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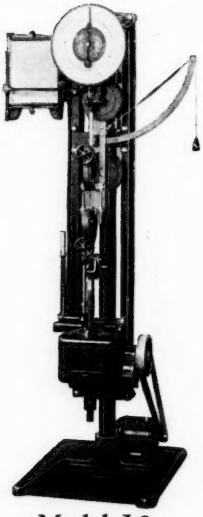

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TESTERS

The Editor's Page

THE whole cotton industry, manufacturers as well as growers, have suffered a serious loss in the death of David R. Coker at his home in Hartsville, S. C., Nov. 28th. While successful in varied lines of business, his vocation, and avocation as well, was cotton breeding. He was the originator of so many and valuable types of cotton that he was referred to often as the Luther Burbank of the cotton growing industry. On his own plantations he gave practical demonstration of the advantage of using pure seed for the production by intensive cultivation of cotton of better grade and staple. He was one of the few cotton authorities who agreed with the writer as to the possibility of producing cottons shorter than the so-called staples with fibres approximating the fineness of the latter, thus making for increased strength of yarn spun from the shorter cottons of fine fibre diameter.

* * *

THE "constant reader" of this magazine probably understands that it is not only the medium for the publication of Textile Foundation and Institute research reports, but that it has endeavored from its inception to provide for the publication of other original research findings; this, of course, in addition to its abstract section reviewing textile research literature throughout the world. The aim is not only to make other results of original research available to our readers and to record them for future reference, but to encourage the individual researcher to further effort. Heretofore, such contributions worthy of a place in these columns have not been numerous, but with the increase of laboratories engaged in textile testing, or control work, or research at mills, educational institutions, associations, or in commercial work, the volume of such matter must increase. Fortunately, this magazine is better able to provide this service than heretofore, and it welcomes an increase in research contributions, with the hope that it will reflect an increased interest by the industry in the need and practical value of research.

* * *

Personal

Harold B. Hoskins, vice-president, Cannon Mills, Inc., New York, N. Y., has been appointed a member of the Institute's Committee on Economic Research. He succeeds W. H. Turner, formerly with Marshall Field & Co., New York, N. Y., who has resigned the latter connection to go into the steel business.

* * *

Nominations of officers and directors of the American Association of Textile Technologists for election at the annual meeting Jan. 11, are as follows: President, Constant Scholer; 1st vice-president, Joseph Meierhans; 2nd vice-president, Dr. E. W. K. Schwarz; treasurer, Rudolph Semmler;

secretary, Bernice Bronner; directors for three years, Dr. J. F. X. Harold, Oscar Geier and H. H. Hatch; directors for two years, E. N. Ditton and Alexis Sommaripa; director for one year, Aubrey Kelley.

* * *

Officers of the American Association of Textile Chemists and Colorists re-elected at the annual meeting in Atlanta, Ga., Dec. 2 and 3, were as follows: President, Alban Eavenson; Vice-presidents, Duncan Ferguson and Arthur R. Thompson, Jr.; Treasurer, William R. Moorehouse. Councillors-at-Large elected for a term expiring Dec. 31, 1941: Peter J. Ariente, Sayles Finishing Plants, Saylesville, R. I., and R. S. Wheeler, Crystal Springs Bleachery, Chickamauga, Ga. The latter succeed Harold M. Chase and Arthur E. Hirst, whose terms expired Dec. 31, 1938.

* * *

Richard W. Arrington has been elected President of the Union Bleachery, Greenville, S. C., succeeding his father, the late John W. Arrington, who had been a director of U. S. Institute for Textile Research for many years. John W. Arrington, Jr., is treasurer and vice-president of the company, and Nelson Arrington is assistant treasurer.

* * *

Science and Empiricism

IF it be true that a successful chopping-out machine has been invented, then the complete mechanization of the cotton plantation from the sowing of the seed to and including the harvesting of the lint is at hand. The mechanical cotton picker could not of itself solve the cotton growers' labor problem, for chopping-out by hand still required a large amount of labor for which there was little or no work during the balance of the season.

* * *

WHILE the following description of the structure of a wool fibre, published in a recent issue of *Time* is neither scientific nor empirical, it is at least intriguing: "A wool fibre consists of: (1) the cortex (scaly outer layer), (2) elasticum (inner layer), (3) core. If soaked in water, the elasticum and core contract, pulling the cortex with them and shrinking the wool 10 to 30%. For years chemists have searched for a way to 'lubricate' these inner parts to prevent shrinking, but most of them failed."

* * *

NYLON differs generically from all other so-called synthetic yarns or fibres in that it is the product of a true synthesis of basic material. So-called synthetic fibres whose bases are cellulose, casein, or chitin start with a natural product which may be degraded somewhat before regeneration, or may be dissolved in some solvent and then reprecipitated in fibre or yarn form.

The Capacitance of Textile Materials in Relation to Moisture Content[a]

By BARBARA BAILEY[b] and ETHEL L. PHELPS[c]

University of Minnesota

Summary

MEASUREMENTS of capacitance, or the so-called dielectric constant, have been used prior to this investigation to determine the moisture content of certain biological materials. The present problem was undertaken to ascertain the change in capacitance of the major textile fibres with variations in moisture content, to observe the difference in values obtained when comparing fibres of diverse origin or of different chemical nature and, incidentally, to determine the usefulness of the particular type of electrical equipment employed for the measurement of moisture content of textile fibres and fabrics. Therefore, milliammeter values for cotton fibre, wool yarn, and rayon, cotton, linen, and silk fabrics (the last both as purchased and after washing) were determined at varying levels of moisture regain by means of the Burton-Pitt apparatus, and the values found are herein reported in milliammeters. Several stages of manufacture were represented in the cotton materials used.

Upon analyzing the change in capacitance with increasing moisture regain, 1% differences in regain were found to be associated with increasingly larger capacitances in general in the following order: animal fibres, rayon, boiled-out cotton fibre[d] and cotton fabrics, raw cotton fibre, and linen. In plotting milliamperes against moisture regain, the resulting curves for the animal fibres, cellulose-acetate rayon, and viscose rayon showed nearly a straight line relationship. The tendency for a curvilinear relationship increased for the materials studied in the following order: cuprammonium rayon, boiled-out cotton fibre and cotton fabrics, linen, and raw cotton Capacitance did not change with increasing regain in cellulose-acetate film.

Milliammeter readings appeared to vary with fibre composition. The capacitance of linen and cotton materials as a group was higher than that of rayons and animal fibres. Values for silk and wool were lower than those for rayons. Due to the change in milliammeter readings as influenced by humidity, milliampere-regain curves for the different kinds of fibre were spread out fan-like as humidity increased.

[a] Paper No. 1631, Scientific Journal Series, Minnesota Agricultural Experiment Station.

[b] Research Assistant, South Dakota Agricultural Experiment Station, Brookings, S. D.

[c] Assistant Professor of Textiles and Clothing, Division of Home Economics, University of Minnesota, St. Paul, Minn.

[d] The term "boiled-out cotton fibre" as used in this paper refers to cotton fibre, previously treated with two per cent caustic soda for six hours in a pressure kier under five pounds pressure.

The results for cotton at different stages in manufacture were not uniform. Raw cotton had a higher capacitance than boiled-out fibre. Bleaching appeared to raise capacitance, while mercerization (comparing values for bleached cotton with and without mercerization) appeared to lower capacitance at regains above 6%. Further purification and modification of cellulose, as represented in the rayons, would seem to have lowered capacitance to a still greater extent than did mercerization.

In only three cases were milliammeter values markedly changed by the removal of finishing materials insofar as this was achieved by washing. After washing, the capacitance of unbleached cotton sheeting and cuprammonium rayon was lower and that of linen was higher, at 6% regain and above, than that found for the fabrics as purchased.

The use of the capacitance method for the determination of moisture would appear to necessitate control of the following factors: fibre, humidity, temperature, "previous history" of the textile, arrangement and distribution of the sample in the tube, and ratio of air to fibre in the textile.

Introduction

The determination of the dielectric constant has been one of the modern physico-chemical methods used in studying the structure of organic materials. Such determinations have served indirectly to disclose significant differences in constitution and also have been found to be related to other properties. Thus the so-called dielectric constants of various materials, such as lignite ("Braunkohle") and grain, have been correlated with their moisture content.

Strictly speaking, the dielectric constant is a property of a homogeneous material and, therefore, will not vary with mass. With regard to the significance of the dielectric constant of a mixture, according to Lowry,[1] the majority of investigators have concluded it to be impossible to calculate such a constant from the dielectric constants of the components. Since it is recognized that a textile product is usually a heterogeneous three-phase system, in this report, instead of speaking of the dielectric constant of these materials, reference is made to the capacitance of the system, fibre–water vapor–air.

Beginning in 1924, Urquhart and his coworkers[2-13] reported the results of a series of investigations on the moisture relations of cotton and other cellulosic textiles. Urquhart[13] defines absorption as the taking up of moisture, desorption as the giving up of moisture, and adsorption as the general process without special indication of gain or loss. Due to differences in the use of the term adsorption in the literature, the term sorption has been used throughout this discussion to designate the general process in moisture relations where neither gain nor loss of moisture is specified. In 1929 Urquhart[10] discussed his explanation of the sorption of water by cotton, following which Peirce[14] postulated a two-phase theory of water sorption by cellulose with the suggestion that this mechanism was simpler than that proposed by Urquhart.[10] In a study of the sorption of water by rayon, Urquhart and Eckersall[12] found that cellulose-acetate rayon, when compared with cotton, had a reduced capacity for water sorption, while nitrocellulose rayon had a higher sorptive ability than other types of regenerated cellulose rayons.

Greenfield [15] in 1936 discussed residual moisture in cellulosic dielectric materials. He concluded it was practically impossible to remove the monomolecular film of water without destroying the cellulose structure.

In a series of papers from the Bell Telephone Laboratories, the results of experiments to show the relationship between electrical resistance and relative humidity in cotton, silk, and wool, have been reported. Murphy [16] in 1929 found the change in electrical resistance of cotton between low and high moisture contents to be more than a hundred-fold. Walker [17] in 1933 added his theory of the sorption of water by cellulosic material to those of Urquhart [10] and Peirce.[14] More recently Walker [18] has further discussed his theory of moisture-cotton hair structure relations and the relationships between the moisture sorbing properties and electrical properties of textiles.

The relationship between dielectric constant and molecular structure has been discussed by Smyth.[19]

Spencer-Smith [20] has suggested an electrical method for measuring the moisture in fabrics which depends on the determination of their capacitance in micro-micro farads. Holl [21] has discussed the determination of the dielectric constant of wool by means of a bridge method, measuring the capacity of the condenser when empty and when filled with the fibre. A mean value of 4.56 for scoured Cape wool yarn was reported.

In the investigation of cellulose-water relationships, Argue and Maass [22] have employed a measurement of the dielectric constant of the adsorbed water and also have pointed out the importance of the arrangement of the fibres with respect to the capacity of the condenser. Recently De Luca, Campbell, and Maass [23] have described a method for the determination of the dielectric constant of fibrous materials which cannot be made to fill a condenser completely. A value of 6.1 was reported for standard cellulose.

Burton and Pitt [24, 25] used an apparatus of their own invention to determine the moisture content of grain. It is probably best classified as an electrical resonance type of apparatus, in which a simple milliammeter is inserted in the circuit to measure the change in current flowing in a secondary circuit, instead of adjusting the capacity of one condenser to balance an unknown capacity. In other words, in the original Burton-Pitt apparatus the capacity of the condenser was not measured directly, but the value of the current flowing was measured by reading the deflection on the milliammeter after introducing the dielectric material into the rapidly alternating electric field of inductances or coils connected across the capacity. The Burton-Pitt device was employed by the Wool Industries Research Association of Great Britain [26] to investigate the use of this method for the determination of the amount of moisture in wool.

Other investigators who have used the dielectric constant method for the determination of moisture in biological materials are Gehman and Weatherby,[27] Berliner and Rüter,[28, 29] Hirz,[30] Hartig and Sullivan,[31] and Cook, Hopkins, and Geddes.[32]

Method

The woven textiles used in this study included viscose and cuprammonium rayon flat crêpe, cellulose-acetate rayon taffeta, unbleached and bleached cotton sheeting, mercerized cotton broadcloth, handkerchief linen, and pure-dye silk flat crêpe. Additional materials included cellulose-acetate film, good middling cotton in the form of both raw and boiled-out fibre, and wool yarn. All of these were undyed. The raw wool used for wool yarn

had been washed in soft water with neutral soap and then spun by hand. With the exception of the cellulose-acetate rayon, all woven materials were purchased at retail, and details of manufacture and finishing were unknown.

The test materials were conditioned in atmospheres of approximately 15, 30, 40, 65, and 85 per cent R.H., using sulfuric acid solutions of known specific gravity in desiccators and in the apparatus described by Wilson [33] and Wilson and Fuwa.[34] Throughout these experiments the room temperature ranged from approximately 70° to 80° F.

The original Burton-Pitt moisture tester was used to measure the capacitance of the textiles. The instrument was calibrated by means of a sealed tube of wheat before each set of triplicate readings was made. The effect on the milliammeter readings of any moisture in the air surrounding the experimental tubes becomes negligible when the apparatus is calibrated each time it is used. After a 20 to 30-minute "warm-up" period, readings can be made very rapidly as the needle on the milliammeter comes to rest immediately when the test material is inserted in the proper position in the instrument.

The tubes in which the experimental materials were placed, measuring 165 mm. inside length and 28 mm. inside diameter, were especially constructed for the purpose, and fitted into the cylindrical space provided in the testing instrument. A hollow stopper in one end of the tube permitted the sample to be cut the full length of the tube in order that the column of experimental material might span the interval provided in the device. Both the stopper and the bottom end of the tube were drawn down to a smaller bore to permit air to pass through the tube at the time it was connected to the conditioning apparatus, and both ends were closed off with small corks during weighing and determination of capacitance.

Twenty gram samples of each of the experimental materials, with the exception of the cotton fibre, were prepared in triplicate. Since the cotton fibre was less compact than the woven materials and wool yarn, it was necessary to use 15 gram samples in this case and to make a correction for weight.

Two series of tests were conducted with each type of woven material used. The first determinations were made on the materials as obtained from the retailer or from the manufacturer; and the second after a washing process was known to have removed starch as shown by an iodine spot test.

All weighings were made on an analytical balance to an accuracy of one in 1000 to 2000 parts in each case.

The samples were subjected for 48 hours to a preliminary conditioning in a desiccator, over sulfuric acid of the proper specific gravity. They were then removed and placed as quickly as possible in experimental tubes. The tubes and contents were weighed, and the tubes connected to the Wilson apparatus, which contained sulfuric acid of the same specific gravity as that in the desiccator. Following a 24-hour conditioning in the Wilson apparatus, the samples and tubes were weighed, placed in the Burton-Pitt instrument, and the milliammeter readings recorded. This procedure was repeated, using four additional sulfuric acid solutions of successively lower specific gravity in order to obtain data for increasing moisture regain. The samples were then removed from the tubes, dried to constant weight according to specifications of the American Society for Testing Materials,[35] and moisture regains calculated.

The washed fabrics were dried under prevailing room conditions, and in all instances the experimental materials were in equilibrium with the prevailing atmospheric humidity before being conditioned as described above. This procedure insured their being carried to progressively higher humidities (i.e. from the dry side) without again being exposed to room conditions, thus avoiding hysteresis effects. Since the fabrics used were purchased on the retail market, their "previous history" as regards drying from the wet state in finishing, or earlier in manufacture, could not be ascertained.

In an attempt to compare the milliammeter values reported herein with capacitance values of other types of materials, a curve showing the relationship between milliammeter readings and corresponding dielectric constants was constructed for samples of organic liquids with known dielectric constants. These values are given in Table 1.

TABLE 1

Milliammeter Readings in Milliamperes and Known Dielectric Constants of Certain Organic Liquids

Organic liquid	Milliamperes	Dielectric constants
n-octane	0.170	1.96 [1]
Toluene	0.220	2.30 [2]
Xylol	0.240	2.50 [2]
Ethyl ether	0.455	4.34 [3]
Chloroform	0.460	5.10 [3]
Amyl alcohol	0.775	16.00 [2]
n-butyl alcohol	0.810	19.20 [2]
Ethyl alcohol	0.880	25.70 [3]

[1] Weissberger and Proskauer[36].
[2] Gehman and Weatherby[37].
[3] MacDougall[37].

Upon examining the data in Table 1 it will be noted that, when using the Burton-Pitt apparatus, the milliammeter readings did not increase at the same rate as the dielectric constants of the materials studied. Since a general relationship of increasing milliammeter values-increasing capacitance (or dielectric constant) is observed, in the discussion which follows, mention of actual values will refer to milliammeter readings in milliamperes as determined experimentally, while in the case of general relationships the term capacitance will be used.

Data and Discussion

Preliminary experiments indicated that changes in moisture regain of approximately 0.50% were required to effect a change of 0.005 milliampere in the milliammeter readings. In other words, the apparatus could be employed in making moisture content determinations of textile materials if an accuracy greater than $\pm$ 0.50% moisture regain were not required.

Further, a difference of approximately five grams in the weight of the material was found to result in a difference of 0.03 milliampere in the milliammeter reading, regardless of the kind of fibre or the percentage of moisture present, with the exception of wool yarn exposed at the lowest

humidity used. This permitted the correction of the milliammeter readings for the material which did not weigh approximately 20 grams at the time the readings were recorded.

In order to obtain the milliammeter values given in Tables 2, 3, 4, and 5, the corrected data for all of the individual determinations were plotted and the resulting curves are shown in Figures 1 and 2.

Moisture Sorption.—Equilibrium at a given relative humidity was found to have been established after an exposure of 72 to 84 hours. When comparing the various fibres at the relative humidities used, moisture regain appeared to have been influenced by manufacturing processes, particularly at the higher humidities. The moisture regains for animal fibres and regenerated cellulose rayons were higher than for cotton materials and linen at each level of relative humidity. Higher moisture regains were found after washing in one-half of the cases in which comparisons could be made between "as purchased" and "washed" fabrics. Three-fourths of the remaining instances showed no significant difference in moisture regain after washing. At 65% R.H., standard moisture regain for the various types of fibre had not been exceeded by any of the materials, with the exception of "washed" mercerized cotton and "washed" cuprammonium rayon.

Capacitance Relationships.—The variables which appear most likely to affect the capacitance of the materials used in this investigation are moisture regain, fibre composition, finishing, temperature, and condition of testing, such as distribution of sample and air in the tube. In this case the influence of sizing materials and processing would be included in finishing. Preliminary tests showed that the effect of temperature, in the

Table 2. Increases in Milliameter Values (in Milliamperes) for Experimental Materials Resulting from Increasing Moisture Regain.

Material*	Moisture regain in intervals of one per cent									
	4 to 5	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	12 to 13	13 to 1
Wool				0.010	0.008	0.009	0.008	0.009	0.009	0.009
Silk*	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	
Cellulose-acetate rayon*	0.013	0.013	0.012	0.013	0.013	0.013				
Viscose rayon*					0.018	0.017	0.018	0.018	0.017	0.018
Cuprammonium rayon*				0.010	0.010	0.015	0.015	0.015	0.020	0.017
Mercerized cotton*	0.022	0.023	0.025	0.025	0.023					
Boiled-out cotton	0.017	0.023	0.025	0.025						
Unbleached cotton*	0.022	0.023	0.025	0.041	0.043	0.061				
Bleached cotton*	0.025	0.025	0.030	0.040	0.060	0.060				
Raw cotton	0.025	0.045	0.075	0.110	0.125					
Linen*	0.055	0.055	0.055	0.060	0.065	0.075	0.080	0.069		

*Values listed are for fabrics after washing

range of 70° to 80° F. which prevailed during the time of experimentation, was negligible. Correction for the size of the sample was made in the manner previously outlined.

It is recognized that no one of these factors operates independently of the others, and that any conclusions drawn should take into consideration all of these variables. In the discussion which follows, data for "washed" samples have been used unless otherwise specified.

A. *Relationship between moisture regain and capacitance.*—Changes in milliammeter values with increases in moisture regain of 1% are shown in Table 2. From these data it is evident that, in the case of animal fibres, increases of 1% moisture regain resulted in approximately the same change in milliammeter readings, and therefore in capacitance, regardless of the total moisture regain. Thus, in plotting data for the animal fibres, a straight line relationship between milliammeter readings and moisture regain would be anticipated within the regain range studied. This is shown to be realized in Fig. 1.

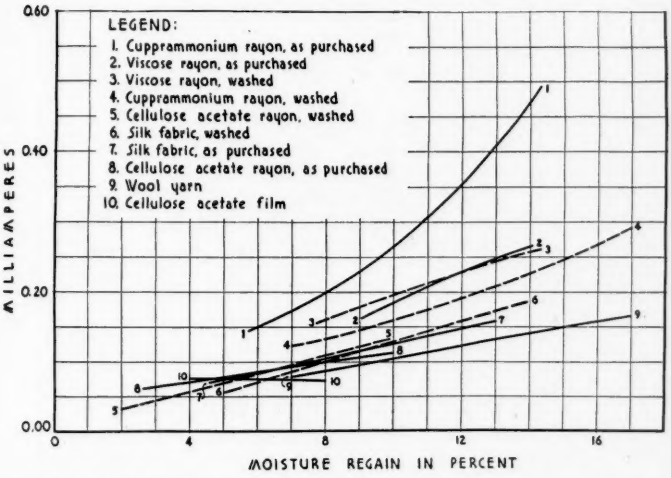

FIG. 1. Relationship between moisture regain and milliammeter readings (in milliamperes) for silk, wool, and rayon materials and cellulose acetate film.

The change in milliammeter values with increasing moisture regain was practically equal for both viscose and cellulose-acetate rayon, as in the case of animal fibres, and the straight line curves for these rayons shown in Fig. 1 were to be anticipated. Also it was to be expected that the slope of the curve would be greater for the viscose than for the cellulose-acetate rayon. Cuprammonium rayon showed an increasing change in milliammeter values with increases in moisture regain and a slightly curved line resulted.

All cotton materials showed a greater change in milliammeter values and therefore in capacitance with 1% increases in moisture regain than rayon fabrics at comparable regains. Since these changes were increasingly greater as regain increased, curvilinear relationships would be anticipated and such are shown by the curves in Fig. 2. Raw cotton fibre and unbleached and bleached cotton fabrics increased in capacitance more rapidly with regain increases than the other forms of cotton used. This was most marked in the case of raw cotton. In plotting these data, curvilinear relationships with steep slopes were expected and such are shown in Fig. 2.

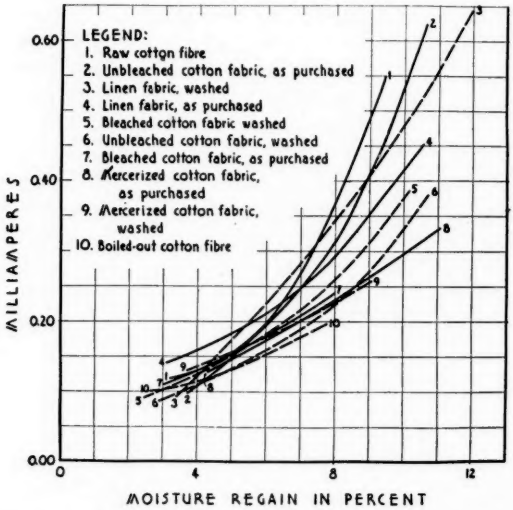

FIG. 2. Relationship between moisture regain and milliammeter readings (in milliamperes) for cotton and linen materials.

Between moisture regains of 4% and 6%, linen increased in capacitance more rapidly than any of the other materials (Fig. 2). Somewhat above this point, at approximately 7% regain, the curve for the raw cotton fibre crossed the curve for linen, indicating a more rapid change in capacitance. At higher regains the curve for linen continued to rise with respect to capacitance, a maximum change in milliammeter readings, 0.080, having been reached between 10% and 11% moisture regain. A curvilinear relationship between capacitance and moisture regain was expected from the experimental data for linen, as well as a steeper slope than was shown for any of the other materials with the exception of raw cotton fibre. Fig. 2 proves this to be the case.

B. *Relationship between fibre composition and capacitance.*—To show the effect of fibre composition on capacitance, milliammeter values for the different materials at moisture regains of 7, 8 and 9 per cent are given in

Table 3. This range was chosen because values for most of the materials were available at these regains.

The capacitance of the animal materials was somewhat lower than that of any of the cellulosic materials, with the exception of cellulose-acetate rayon. However, in this respect, rayons appeared to resemble animal materials more nearly than other cellulosic materials.

TABLE 3

Milliammeter Values (in Milliamperes) for Materials of Diverse Fibre Composition at Moisture Regains of 7, 8, and 9%

Material	Moisture regain in per cent		
	7%	8%	9%
Wool	0.080	0.010	0.098
Silk *	0.100	0.115	0.130
Cellulose-acetate rayon *	0.095	0.108	0.121
Cuprammonium rayon *	0.125	0.135	0.145
Viscose rayon *		0.162	0.180
Boiled-out cotton	0.180	0.205	
Unbleached cotton *	0.180	0.221	0.264
Mercerized cotton *	0.205	0.230	0.253
Bleached cotton *	0.215	0.255	0.315
Raw cotton	0.270	0.380	0.505
Linen *	0.285	0.345	0.410

* Values listed are for fabrics after washing.

All of the cotton and linen materials reported herein as a group had relatively high milliammeter values. Among the forms of cotton studied, higher capacitances were indicated in general in the order of listing; i.e., (1) boiled-out fibre, (2) unbleached fabric, (3) mercerized fabric, (4) bleached fabric, and (5) raw fibre. Within this range, raw cotton fibre had an appreciably higher capacitance than any of the other forms of cotton. Also, at these regains, linen had a higher capacitance than any of the other cellulosic textiles, with the exception of raw cotton fibre, above 7.5% moisture regain.

C. *Relationship between stage of manufacture and capacitance.*—The cotton materials used represent important processes to which cotton is subjected in the course of manufacture. Raw cotton fibre may be boiled-out and cotton fabrics are sold in the unbleached, bleached and mercerized state. Highly purified cotton linters commonly are used as the source of alpha cellulose in the manufacture of cuprammonium rayon. In the flax fibre cellulose is associated with pectic substances.

Both raw and boiled-out fibre sorbed moisture to approximately the same degree as the three cotton fabrics, and thus could be used for direct

comparisons of the capacitances of the fibre with the washed materials. Table 4 shows the comparative milliammeter values for all the cellulosic textiles studied, at moisture regains of 4–8%.

The difference in milliammeter readings and therefore in capacitances at 4% and 8% moisture regain was greater for the raw fibre than for the cotton fabrics, but the difference for the boiled-out cotton fibre was less than for these fabrics (Fig. 2).

No significant difference was observed between the milliammeter values for the boiled-out fibre and for the unbleached fabric in the range of 4–7% moisture regain, but at 8% the reading for the fabric was higher than that for the fibre. However, both were lowest at all of these regains. At moisture regains of 4% and 5%, the milliammeter values for bleached and mercerized fabrics were higher than those for raw and boiled-out fibre and unbleached fabric. Above 5%, values for raw fibre increased rapidly with moisture regain and exceeded those for the other cotton materials. Mercerized and bleached fabrics had approximately equal milliammeter values up to about 6% moisture regain, and at 8% the reading for the bleached fabric was 0.025 milliampere higher than that for the mercerized fabric. Hence mercerization may lower capacitance at regains above 6%.

Table 4. Milliameter Values (in Milliamperes) for the "Washed" Cellulosic Textiles, Cotton and Cellulose-Acetate Film at Moisture Regains of Four through Eight Per Cent

Experimental Material	Moisture regain in per cent					Difference in milliamperes at 4 & 8% moisture regain
	4	5	6	7	8	
Raw cotton	0.125	0.150	0.195	0.270	0.380	0.255
Boiled-out cotton	0.115	0.132	0.155	0.180	0.205	0.090
Unbleached cotton fabric	0.110	0.132	0.155	0.180	0.221	0.111
Bleached cotton fabric	0.135	0.160	0.185	0.215	0.255	0.120
Mercerized cotton fabric	0.135	0.157	0.180	0.205	0.230	0.095
Cuprammonium rayon fabric				0.125	0.135	
Viscose rayon fabric				0.162	0.180	
Cellulose-acetate rayon fabric	0.057	0.070	0.083	0.095	0.108	0.051
Cellulose-acetate film	0.075	0.075	0.075	0.075	0.075	0.000
Linen fabric	0.120	0.175	0.230	0.285	0.345	0.125

Rayons represented the most highly purified form of cellulose studied. However, comparisons between regenerated cellulose rayons and other cellulosic textiles were difficult since milliammeter values were not available in the same range of moisture regain. At 7% and 8% moisture regain, where these were known, the milliammeter readings for the rayons were appreciably lower than those for any other cellulosic materials, cellulose-acetate rayon and film being lowest of all. Cuprammonium rayon had a lower value than viscose rayon in every instance (Fig. 1). The cellulose-acetate film resembled the cellulose-acetate fabric in that the amount of moisture sorbed and the milliammeter values recorded were low for each (Table 4). Unlike the cellulose-acetate fabric, the film appeared to have the same capaci-

tance at all regains. Rayon fabrics and film more closely resembled the protein materials than the other cellulosic textiles, in that even at high percentages of moisture regain the increase in milliammeter readings was gradual and did not attain to values found for cotton and linen fabrics having 3–5% lower moisture regains. Above 5% regain, linen behaved more nearly like cotton than did rayon. With the exception of raw cotton fibre at moisture regains of 8% and 9%, linen had higher milliammeter values than any of the other cellulosic textiles.

D. *Relationships between removal of finishing materials by washing and capacitance.*—The condition of the woven textiles at time of testing, i.e., whether they were "as purchased" or "washed," affected the capacitance of certain fabrics, particularly at higher moisture regains. Insofar as washing removed finishing materials, those fabrics least affected by this treatment were bleached and mercerized cotton, viscose rayon, cellulose-acetate rayon, and silk (Table 5).

Table 5. Changes in Milliameter Values (in Milliamperes) at Different Moisture Regains Due to Washing Experimental Fabrics

Material	Moisture regain in per cent											
	3	4	5	6	7	8	9	10	11	12	13	14
Unbleached cotton		+0.010	-0.013	-0.035	-0.057	-0.078	-0.121	-0.235	-0.265*			
Bleached cotton		+0.007	+0.010	+0.008	+0.010	+0.020						
Mercerized cotton		+0.015	+0.007	0.000	-0.005	-0.010	-0.017					
Cuprammonium rayon					-0.050	-0.065	-0.085	-0.110	-0.135	-0.170	-0.200	-0.248
Viscose rayon							+0.015	+0.013	+0.005	+0.003	0.000	+0.013
Cellulose-acetate rayon	-0.020	-0.015	-0.008	-0.002	+0.002	+0.008	+0.015	+0.020				
Linen		-0.040	-0.010	+0.020	+0.035	+0.048	+0.050	+0.060				
Silk		-0.018	-0.013	-0.008	-0.003	0.000	+0.003	+0.007	+0.010	+0.013		

*Value for 10.5 per cent moisture regain

The milliammeter values for bleached cotton were higher after washing than "as purchased" at all regains for which data were available. In the case of viscose rayon, these values for the "washed" fabric were higher than for the material "as purchased," except at 11, 12 and 13 per cent, where the two were about equal. For mercerized cotton the milliammeter readings were higher for the "washed" fabric at 4% moisture regain, while above 7% these were higher for the fabric "as purchased." Washing affected the capacitance of cellulose-acetate rayon and silk similarly, in that milliammeter values for the materials "as purchased" were higher at lower regains and those for the fabrics after washing higher at higher regains, the transition regain rising in the order of mention. This is the reverse of the change noted for mercerization.

Those textiles which were appreciably affected by the washing process were unbleached cotton, cuprammonium rayon, and linen (Table 5). At moisture regains of 4% and 5%, the milliammeter values for "washed"

linen were lower than those for the fabric "as purchased." At 6% and above, milliammeter values for the "washed" material were increasingly higher than those for the fabric "as purchased." Cuprammonium rayon and unbleached cotton fabric in all but one case had higher milliammeter values before washing. This was especially marked at the higher moisture regains, where values for the unwashed fabrics in both cases indicated rapidly increasing capacitances.

The markedly high values found for unbleached cotton and cuprammonium rayon "as purchased" may have been due to finishing materials used, since the unbleached cotton, which contained starch before washing, showed less tendency to sorb water after removal of the finishing materials, and cuprammonium rayon sorbed more water after the finishing materials had been removed.

In conclusion it should be noted that moisture regain, fibre composition, stage of manufacture, and presence of finishing materials all have been shown to influence the capacitance of textile materials. Other variables which presumably may affect these measurements are temperature, "previous history" of the textile, arrangement and distribution of the sample in the tube, and the ratio of fibre to air in the sample. The use of capacitance measurements as a means of determining moisture content in the light of these findings would appear to require the control of all but one of these variables. The type of apparatus employed would constitute another important consideration, since the device used in this investigation was limited in sensitivity to changes of about $\pm 0.50\%$ moisture regain.

Acknowledgment

The authors express their gratitude to Dr. C. H. Bailey and Dr. George Glockler for helpful criticisms and suggestions during the course of this investigation, and to the Division of Agricultural Biochemistry for the use of apparatus to measure capacitance.

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Stabilization of the Viscosity of Potato Starch Pastes

By DR. J. R. KATZ *

A Research of U. S. Institute for Textile Research

Effect of Neutralization With Sodium Carbonate

POTATO STARCH is generally slightly acid. This acidity is due to the amylophosphoric acid in the starch granule. In order to study the full effect of the degree of neutralization of the acid on gelatinization and disintegration of swollen granules, the best way, according to my opinion, is, first, to take away all the alkaline substances (potassium, magnesium, etc.) which neutralize the amylophosphoric acid, and then to add different amounts of dilute alkali (calculated as a fraction of the amount of alkali needed to neutralize starch against phenolphthalein). As alkali I use sodium carbonate, or bicarbonate, because sodium hydroxide would not only neutralize phosphoric acid of the starch, but also get adsorbed on the hydroxyl groups of the starch.

Wolff and Fernbach,[1] two well-known French starch workers, gave in 1905 a simple prescription of how to remove the alkali which neutralizes the phosphoric acid groups of the starch. They treated starch at room temperature with the 300-fold amount of 0.1% hydrochloric acid, stirring constantly and intensively with a glass stirrer. Then they washed the starch repeatedly with the same amounts of distilled water until they were certain that all the hydrochloric acid had been removed. (On dissolving some of the wet starch in strong nitric acid and adding silver nitrate there should be no turbidity after standing for 24 hours.) They called such potato starch "demineralized potato starch."

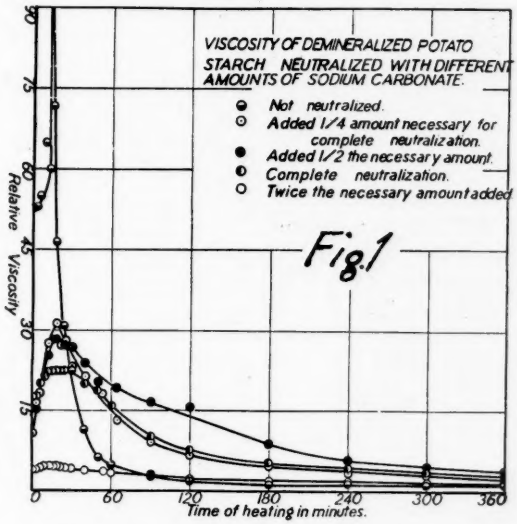
This method I found to be very practical, if one only makes certain that no trace of chloride is left in the starch. I must emphasize that this point is essential for getting reproducible results.

The 1% starch paste was made up in the following way: One g. of air-dry starch was mixed with 25 cc. of water. Then 70 cc. of water at 100° C. were added until a very homogeneous paste was formed. Then the paste was heated for 2 min. in Pyrex glass in a waterbath at 100° C. and then cooled for a minute under running water. Then 1/50 N sodium carbonate was added from a burette. Five cc. were needed to get a slight pink color with phenolphthalein. The paste mentioned (neutralized or not neutralized) was heated under a reflux condenser at 99° C. and samples were taken from time to time for viscosity measurements.

* The late Dr. Katz was director of the Institute's warp sizing study at Massachusetts Institute of Technology until January, 1936.

[1] Jules Wolff and A. Fernbach. De quelques circonstances qui influent sur l'etat physique de l'amidon. *Compt. rend., 140,* 1403–6 (1905).

Then partial neutralization and over-neutralization were studied. One-quarter, one-half and the double amount of Na_2CO_3 (needed for neutralization) were added (Fig. 1), always making up to a total volume of 100 cc. In the top of the curve for demineralized starch it is somewhat difficult to get reproducible values, because the breaking down of the vesicles is so rapid; after 30 min. of heating the data for demineralized starch can be reproduced within experimental errors. The other curves are reproducible throughout within experimental errors.



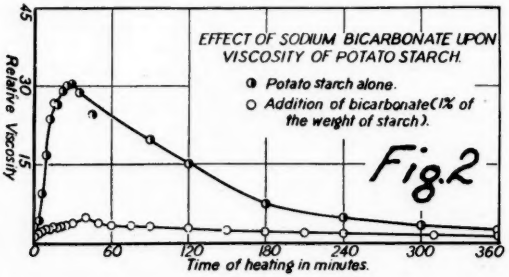
While the demineralized starch is still acid a high maximum of swelling is reached, but the breaking down is equally rapid. That maximum is reached in about 10 minutes (ordinary potato starch in 20–30 min.). Analysis of the curve shows that both the swelling and the degradation of the starch granules are more rapid in the same time.

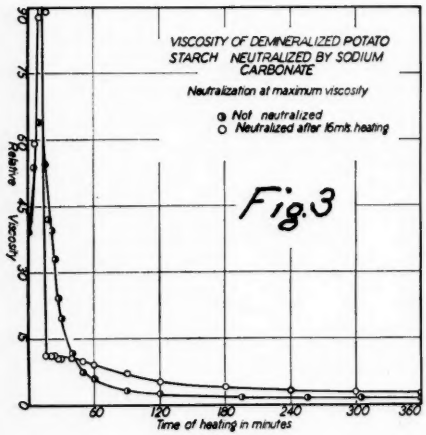
The more sodium carbonate we add, the lower the maximum lies in the viscosity curve. If we add twice the amount of anhydrous sodium carbonate necessary for neutralizing the demineralized starch we get a curve which is practically horizontal, showing only a slight maximum.

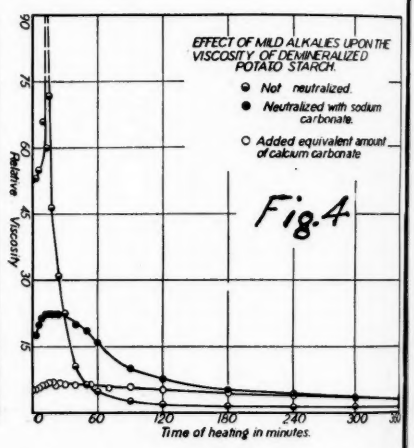
Fig. 2 shows an analogous influence of sodium bicarbonate on ordinary potato starch. If 1% of Na H CO_3, based on the air-dry weight of the starch, is added to potato starch before gelatinization, the maximum is practically flattened out and the vesicles disappear very slowly. Therefore, addition of sodium carbonate or bicarbonate gives to potato starch many of the qualities of a grain starch (corn starch for instance).

Fig. 3 illustrates a third experiment. At its maximum viscosity the starch paste was neutralized with 1/50 N sodium carbonate against phenol-

phthalein. One sees how strongly the viscosity suddenly drops. At the same time the sediment volume (at 2–° C.) drops very strongly. Where demineralized starch does not show any sediment volume at the maximum







(because the vesicles are so strongly swollen that they fill up the whole of the liquid), the demineralized starch taken to the maximum and then neutralized shows a clear sediment volume.

Effect of Neutralization with Alkalis and Salts

If the demineralized starch is neutralized with the amount of calcium carbonate (equivalent to the amount of sodium carbonate) necessary for neutralization against phenolphthalein, we get Fig. 4. The calcium carbonate curve lies very much lower than the sodium carbonate curve and shows practically no indication of a maximum. Effects of the same kind can be obtained by addition of small amounts of different salts to paste made from ordinary (non-demineralized) potato starch.

Fig. 5 shows the effect of adding to 100 cc. of starch paste different salts in the same molar amounts as the sodium carbonate necessary for neutralization against phenolphthalein. The salts used were sodium sulfate, calcium sulfate and magnesium sulfate. While the maximum in the viscosity curve without addition of salt lies at a relative viscosity above 40, the maximum with sodium sulfate lies at about 12, with calcium sulfate around 10, and with magnesium sulfate about 8.5. Therefore, one sees that hard or soft water and the degree of acidity of starch may make a difference in the viscosity curves of potato starch paste. Were this work continued with the more concentrated solutions actually used in sizing it seems possible that it might lead to technical application. But, of course, it must be remembered that such a potato starch paste with low viscosity will size the yarn in a different way than a potato starch paste with a high viscosity.

Effect of Destroying the Growth Structure by Milling

If potato starch is milled in a ball mill the growth structure is gradually destroyed; but to reach this stage one must mill for a long time. Evidently a ball mill is not the instrument best fitted to destroy the growth structure; certain industrial mills could do it far better, and in a much shorter time. In the International Exhibition in Ghent (Belgium) in 1913 I saw an industrial French product called "atomized starch," which had been so milled as to lose its growth structure practically completely, and which was sold at a cost not very much larger than that of the original starch.

The destruction of the growth structure by milling (or by rubbing in a mortar) is characterized as follows:

(*a*) Starch swells in cold water and becomes more and more soluble in it.

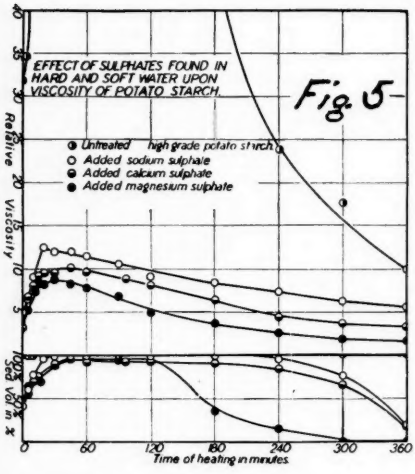
(*b*) The typical black polarization cross between crossed nicols has disappeared; the material has become far less anisotropic; in thin layers it seems to be isotropic, but in thick layers it still shows some optical anisotropy.

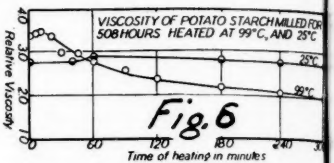
(*c*) The sharp crystalline X-ray pattern of the native starch has disappeared and made place for another pattern, often, according to the kind of starch, a diffuse one.

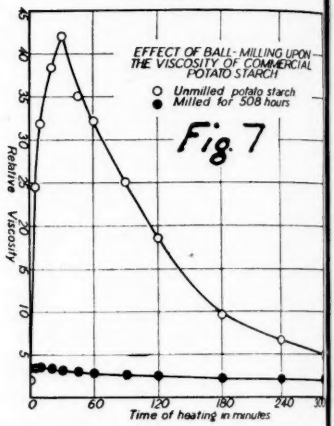
The milling has destroyed the crystalline lattice of the native starch, and eventually changed the starch into another modification. Many other crystals are known which do not withstand long milling without losing this crystalline structure; even quartz is quoted as such. I would like to present the following explanation: When such materials swell or go into solution they do not have to overcome the lattice energy of the crystals, so they will swell or dissolve more easily.

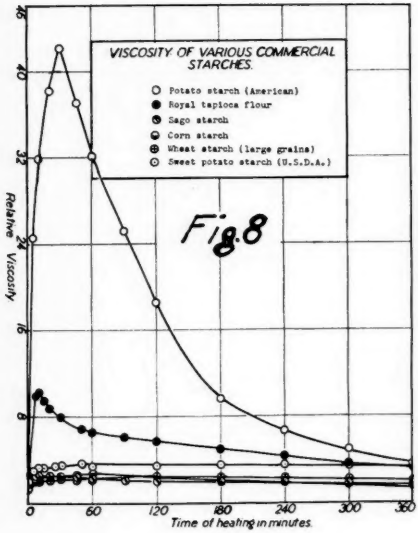
Fig. 6 shows the increase in viscosity in potato starch milled for a long time when a 1% mixture is made up with water at room temperature and kept at 25° C. So, as one sees, the starch actually swells the more in cold water the longer it has been milled. A large ball mill filled with pebbles was used for this milling, which was continued for over 500 hours.

In Fig. 7 we see how the milled starches behave when kept in a 1% solution at 99° C. in Pyrex glass without stirring. One g. of air-dry starch


EFFECT OF SULPHATES FOUND IN HARD AND SOFT WATER UPON VISCOSITY OF POTATO STARCH.
Fig. 5
Untreated high grade potato starch
Added sodium sulphate
Added calcium sulphate
Added magnesium sulphate
Relative Viscosity
% Sed Vol in x
Time of heating in minutes.


VISCOSITY OF POTATO STARCH MILLED FOR 508 HOURS HEATED AT 99°C. AND 25°C
Fig. 6
25°C
99°C
Relative Viscosity
Time of heating in minutes


EFFECT OF BALL-MILLING UPON THE VISCOSITY OF COMMERCIAL POTATO STARCH
Unmilled potato starch
Milled for 508 hours
Fig. 7
Relative Viscosity
Time of heating in minutes


VISCOSITY OF VARIOUS COMMERCIAL STARCHES.
Potato starch (American)
Royal tapioca flour
Sago starch
Corn starch
Wheat starch (large grains)
Sweet potato starch (U.S.D.A.)
Fig. 8
Relative Viscosity
Time of heating in minutes.

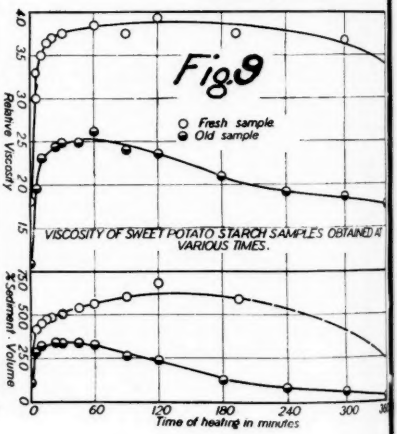


Fig. 9
Fresh sample
Old sample
VISCOSITY OF SWEET POTATO STARCH SAMPLES OBTAINED AT VARIOUS TIMES.
Relative Viscosity
% Sediment Volume
Time of heating in minutes

was mixed with 25 cc. of cold water, then 75 cc. of water at 100° C. were added. It has lost practically all of the characteristics of potato starch, and now behaves practically like a grain starch—wheat starch, for instance.

If we are correct in our hypothesis that it is the growth structure of the starch granule which makes it swell in warm water to a vesicle, and if it is the disintegration of these vesicles, which, in the case of potato starch, leads to the rapid change in viscosity on heating, then the milled potato starch must have an almost constant viscosity (in a 1% paste).

Fig. 7 shows that protracted ball-milling has just the effect we expected. Therefore an industrial "atomized potato starch" might be an excellent size with a practically stable viscosity, if it could be produced cheaply enough.

Sweet Potato Starch

Two samples of sweet potato starch were studied in 1% pastes; an old one and a fresh one. Heated without stirring in Pyrex glass at 99° C., Figs. 8 and 9 were obtained. Fig. 8 compares sweet potato starch with corn, ordinary potato, tapioca, sago, and wheat starches. Fig. 9 compares the two samples of sweet potato starch and includes the sediment volumes. It also shows to which degree viscosity and sediment volume run parallel.

Our results confirm very well the experiments of the U. S. Bureau of Chemistry and Soils, made in 3% pastes. Sweet potato starch swells very much less than ordinary potato starch, and accordingly has a lower but a much more constant viscosity in 1% pastes. Yet this viscosity and its changes are larger than in the case of grain starches.

Probably the main factor in these differences between the native starches is the degree to which the starches swell in gelatinization (in a dilute paste in which they are free to swell as much as they can). This determines their viscosity and the degree to which the viscosity is diminished by heating and by stirring.

Note—The experiments described in this report were executed by Dr. M. C. Desai, as a volunteer to the warp sizing research.

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(*Continued from Front Cover*)

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Abstracts

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E. R. Schwarz, Chm., Dr. E. J. Saxl, C. H. Clark.

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I. Fibres (Synthetic and Natural) and Fibre Analysis

Bonding Force of Cellulosic Materials for Water from Specific Volume and Thermal Data. A. J. Stamm and L. A. Hansen. *J. Phys. Chem.*, 1937, V. 41, P. 1007–16; abs. in *Paper Trade J.*, April 28, 1938, P. 90. (C)

Casein Fibre (Lanital): Its Properties and Its Manufacture. H. G. Bodenbender. *Silk & Rayon*, May 1938, P. 456, 458. (C)

Casein Staple Fibre: Production. H. Söhngen. *Kunstseide*, 1938, V. 20, P. 78–82; abs. in *J. T. I.*, June 1938, P. A324.

Early attempts to spin casein fibres are mentioned and it is pointed out that the casein prepared by the usual methods is not suitable for spinning into fibres. Suitable products can be obtained by using excess acid to precipitate casein from milk. Spinning solutions are prepared by dissolving casein in caustic soda and acid spinning baths are used. Details are given of procedures for the preparation and solution of the casein, and the spinning, cutting and after-treatment of the fibres are discussed. The spinning of mixtures of viscose and casein solution is mentioned. (C)

Cellulose and Modified Cellulose: Action of Ozone on. Charles Dorée and A. C. Healey. *J. T. I.*, March 1938, P. T27–T42.

Although the molecular chain theory provides a reasonable explanation of the effects produced on cellulose by the action of acids (hydrocellulose

formation) the action of oxidizing agents is far more complicated and its mechanism by no means clear. Oxidation experiments are usually carried out in solution and the results are influenced by changes in the pH of the solution and the by-products formed. In the case of ozone, the system is prima facie less complex and to obtain further evidence for the mechanism of oxycellulose formation the study herein reported was made of the action of ozone on cotton cellulose itself, and on the same cellulose after submitting it to the processes of mercerization, hydrolysis, oxidation and acetylation. (C)

CELLULOSE: DEGRADATION BY BLEACHING AGENTS. M. Staudinger and J. Jurisch. *Papierfabr.*, 1937, V. 35 *Techn.*, P. 462–9; abs. in *J. T. I.*, March 1938, P. A149.

The authors review work on the oxidizing effect of bleaching agents on cellulose. Viscosities and degrees of polymerism are recorded from experiments with chlorine water, chloride of lime, chlorine dioxide, hydrogen peroxide and potassium permanganate with cotton in different states. The results are graphically reproduced and show that chlorine dioxide has a very good bleaching effect but a very slow degrading action in comparison with chlorine, chloride of lime and potassium permanganate. Hydrogen peroxide in acid solution is also an oxidizing agent that causes little degradation. (C)

CELLULOSE PROPIONATE THREADS AND FILMS: PRODUCTION AND PROPERTIES. F. Ohl. *Kunstseide*, 1938, V. 20, P. 42–4; abs. in *J. T. I.*, May 1938, P. A262. (C)

(THIS) CHITIN BUSINESS. A. Tsimehe. *Rayon & Silk J.*, March 1938, P. 26–7.

Chitin and its products are closely related to cellulose, but contain the element nitrogen in their molecular structure. The isolation and purification of the material is described and also the method for the deacetylation of it without degradation, which has recently been patented. Of the physical properties of the deacetylated chitin salts which are discussed, the viscosity and adhesive characteristics are the most important. The high viscosity of dilute solutions indicates the high molecular size of the primary particles, and the adhesive character is the property which makes the material of great textile interest. The uses of these viscous solutions in sizing, printing, waterproofing, and delustring are discussed in relation to other recent methods. (C)

II. YARNS AND FABRICS

BASIC YARN FORMUA AND RELATION OF ALL COTTON ROVING AND YARN CALCULATIONS TO THIS FORMULA. Horace L. Pratt & G. Emery Nash. *Cotton*, 1938, July, P. 52–4; Aug., P. 56–7; Sept., P. 62–3; Nov., P. 53–4.

In the four articles of this series the authors have covered the entire range of cotton roving and yarn calculations, claiming that when their

basic formula is used, a rule for each step is unnecessary; the basic formula being $\frac{\text{Length} \times \text{Unit of weight}}{\text{Actual weight} \times 840 \times \text{Counts}} = 1$. (C)

CORRELATION OF DIAMETER AND DENIER FOR RAYON STAPLE FIBRES. Fred. A. Mennerich. *Rayon Tex. Mo.*, June 1938, P. 53–5.

The author gives diameter measurements of the common rayon staple fibres and a practical method of obtaining them. He points out the difference between the densities of viscose and acetate staple fibres and gives tables and curves of common deniers and their corresponding micron diameters. (C)

DYEING: QUICK IDENTIFICATION OF FIBRE CONTENT IN UNION FABRICS BEFORE. Anon. *Rayon Tex. Mo.*, May 1938, P. 61–2. (C)

FINISHING OF MODERN ALL-SPUN RAYON FABRICS. B. S. Hillman. *Rayon Tex. Mo.*, 1938, April, P. 79–81; May, P. 59–60; June, P. 57; July, P. 67, 90; Oct., P. 65–6; Nov., P. 42–3. (C)

FLAX DRESSING AND PREPARING. S. A. G. Caldwell. *Text. Mfr.*, Oct. 1938, P. 410–1.

A review of recent improvements in flax preparatory processes. (C)

RAYON SLASHER: IMPORTANCE OF REMOVING CONDENSATE IN. E. H. Hammond. *Rayon Tex. Mo.*, May 1938, P. 52–3. (C)

REEDING. A. Weber. *Mell. Textilber.* (German Edition), 1938, No. 9, P. 715.

The chief points to observe during the process are (1) the number of ends per inch, (2) the yarn count, (3) the quality of the yarn, and (4) the weave. The author gives a number of examples showing how the weave can be favorably influenced by reeding. (C)

SCREEN PRINTING. R. D. Greene. *Rayon Tex. Mo.*, June 1938, P. 64–6.

The author describes the screen printing process as it is practiced in this country. (C)

SCREENS FOR PRINTING: PRODUCTION OF. Albert Franken. *Mell. Textilber.* (German Edition), 1938, No. 10, P. 802.

The author describes several methods developed as the result of working practice for rationalizing and improving the preparation of printing screens by photo-mechanical methods. Particular attention has thereby been devoted to improving the quality, because the photographic process always guarantees everywhere the utmost fineness and fidelity to the original. The article contains a number of illustrations of the latest types of auxiliary equipment for the photo-mechanical production of printing screens. (C)

SIZING RAYON WARPS: SOME GENERAL COMMENTS ON. Phil. A. Ment. *Cotton*, June 1938, P. 58–9.

The author of this practical discussion modestly states that the information given is based on procedure found workable in his own case, but that unless specific conditions are known it is impossible to give details that would apply to all cases. (C)

SLASHING OF SPUN RAYON WARPS. W. L. Bentley. *Rayon Tex. Mo.*, May 1938, P. 49–51.

The author presents the results of a study which he had recently completed, and which indicated that "technical gelatin-base size correctly applied filled all the requirements of practical standards." The article is accompanied by charts showing tenacity and elongation of sized and untreated yarns made on the Scott Inclined Plane Single End Tester. (C)

SPONTANEOUS COMBUSTION OF GREASY WOOL TEXTILES. Kehren. *Mell. Textilber.* (German Edition), 1938, No. 9, P. 735.

The author describes the investigation of two cases of spontaneous combustion of recovered wool which are specially interesting because the material had been lubricated with mineral oil and not with olein. Examination showed that there were no oil residues to be found in the recovered wool, nor any fatty components with oxidizable properties; the material was free from highly saturated fatty acids and was accordingly to be regarded as not presenting any risk of fire. It was found that the risk of fire arose during the drying process after dyeing; a series of experiments showed that catalytic oxidation processes were to blame. A second fire originated almost certainly in the same way, because it broke out under exactly the same conditions. Although there was not sufficient material in its original condition available for examination, it was still possible to recognize with every certainty that the residue of the lubricant containing mineral oil as extracted in the Mackey apparatus was capable of oxidation by the chroming process. The presence of chromium, which has a catalytic effect, was further demonstrated in the residual ash of the extract. (C)

TECHNOLOGICAL PROCESSES OF LATEST DRAFTING SYSTEMS. G. Krauter. *Mell. Textilber.* (German Edition), 1938, No. 9, P. 709.

The author describes the development of the four-roller "pull-through" system from the Jannink drafting system and the original three-roller system with its nip. A particular disadvantage of the four-roller system was the rotary movement given to the pull-through roller by the fibre masses. Professor Johannsen solved that problem by means of a grooved roller. Von Trümbach used a transversely grooved roller in which the fibres were laid into the flutings. Casablanca's design of a double-band drafting machine is superior to the roller system, as far as guiding the fibres is concerned. The bottom belt drafting system is another design of recent date. The author discusses chiefly the systems devised by Toenniessen, Kluftinger, and Braumüller, referring especially to the lifting of the leather at the turning over of the single-band drafting machine; this bending of the leather provides special elasticity at the nip of the top roller. (C)

TEXTILE PRINTING: DESCRIPTION AND STUDY OF. C. Norris Rabold. *Cotton*, Mar. 1938, P. 53–5, 70; II, DESCRIPTION OF THE EQUIPMENT. *Ibid.*, Apr. 1938, P. 78–80; III, ENGRAVING THE ROLLS, ARRANGING THE COLORS FOR PRINTING, AND SOME COMMON PRINTING TROUBLES. *Ibid.*, June 1938, P. 52–4, 101; IV, APPLICATION OF PRINTING THICKENERS AND COLORS TO COTTON FABRICS. *Ibid.*, Aug. 1938, P. 58–63. (C)

TIME STUDY TESTS ON THE ROVING FRAME: HOW TO MAKE. A Practical Procedure with Practical Results. Furman H. Martin, Jr. *Cotton*, June 1938, P. 50–1. (C)

VARIOGRAPH: A NEW PATTERN PRODUCER. *Rayon Tex. Mo.*, May 1938, P. 72–3.

The Variograph pattern producer (U. S. Pat. appld.) is a new optical device which produces automatically an endless number of fancy patterns. It is described, and designs obtained with it are illustrated. (C)

"VINYARN" AND ITS PROPERTIES. *Rayon Tex. Mo.*, June 1938, P. 58. (C)

WATERPROOFING OF ROPES. "Cantab." *Text. Mfr.*, Sept. 1938, P. 390.

New methods of treatment of twines and ropes, instead of tarring. (C)

WEAVING REVERSIBLE PLUSH FABRICS WITH PILE ON BOTH SIDES: NEW METHODS OF. H. Arnold. *Mell. Textilber.* (German Edition), 1938, No. 10, P. 787.

Reversible pile fabrics with pile on both sides have hitherto had to be woven with the aid of extra picks equal in length to the width of the cloth, the whole of which was rejected and wasted after the pile threads had been drawn on the back. To prevent this waste of extra pick material, the double pile loom is fitted with change boxes on both sides with three or four shuttles. The extra picks are then allowed to run separately from the ground picks and can be wound up again by means of a device in the form of a reel. (C)

III. CHEMICAL AND OTHER PROCESSING (NOT OTHERWISE CLASSIFIED)

GLYCERIN: USES OF—IN TEXTILES. A Review. Georgia Leffingwell and Milton A. Lesser. *Rayon Tex. Mo.*, 1938, May, P. 66–7; June, P. 67–8, 88. (C)

DYEING AND FINISHING OF RAYON HOSIERY. Ross M. Stribling. *Am. Dye. Rptr.*, Sept. 5, 1938, P. 489–96.

Paper presented at meeting, Piedmont Section, A. A. T. C. C., May 7, 1938. (C)

DYEING OF IRIDESCENT HOSIERY. Henry Dixon. *Am. Dye. Rptr.*, Sept. 19, 1938, P. 520–2.

Paper presented at meeting, Piedmont Section, A. A. T. C. C., May 7, 1938. (C)

DYEING COTTON RAW STOCK. Andrew Fisher. *Am. Dye. Rptr.*, Sept. 19, 1938.

A practical review based upon actual experience. (C)

DYEING AND FINISHING MACHINERY: NEW DEVELOPMENTS IN. George Lane. *Am. Dye. Rptr.*, May 30, 1938, P. 294–8.

Paper presented at meeting of New York Section, A. A. T. C. C., Jan. 28, 1938; relates to the continuous scouring or boiling-off unit, the constant speed tensionless jigger dyeing machine, the decatizing or decating machine. (C)

RAYONS: PREPARATION, PRINTING AND FINISHING OF. P. J. Wood. *Am. Dye. Rptr.*, May 30, 1938.

Paper presented at meeting, R. I. Section, A. A. T. C. C., Jan. 28, 1938. (C)

WASHABLE FINISHES (for Staple Fibre Fabrics). *Mell. Textilber.* (German ed.), 1938, No. 5, P. 445.

The Staatliches Materialprüfungsamt, Berlin-Dahlem, has carried out a series of comparative tests on a staple fibre fabric with and without the application of a finish with Tylose 4 S, in order to determine the extent to which this finish improves the quality of staple fibre fabrics. These tests covered the following points: tensile strength and elongation, bursting strength, resistance to abrasion in the wet and dry states respectively, not only in mill condition, but also after the first, fifth, and tenth laundrying respectively in respect of changes in length, finally dealing with the external appearance of the goods. Tylose 4 S is an alkaline solution of cellulose and is therefore, from a chemical point of view, the same basic substance of which staple fibre, rayon, and cotton are also composed. It does not need much consideration to show that the attempt to combine like with like has most chance of success. Practically speaking, the process aims at uniting the cellulose of the fabric with the cellulose of the finishing agent, in order simultaneously to strengthen and reinforce the fibres and to produce a finish on the fabric. The summary states that the finish with Tylose 4 S represents an improvement in the quality of the fabric which finds its expression chiefly in improved strength in the wet state and resistance to abrasion, while the fullness of the handle is brought out well. The article is accompanied by a series of tables showing the improvement effected. (C)

WATERPROOFING COTTON DUCK AND CANVAS. Felix B. McLain. *Am. Dye. Rptr.*, Sept. 19, 1938, P. 507–17.

A comprehensive review of the methods, machines and formulas. (C)

WATER REPELLENCY: SOME ASPECTS OF. Rudolph Linenmaier. *Am. Dye. Rptr.*, May 30, 1938, P. 286–9.

Paper presented at meeting of New York Section, A. A. T. C. C., Feb. 25, 1938. A general review of methods and tests. (C)

WOOL: UNLEVEL DYEING OF—WITH ACID AND CHROME DYES. PART II. A METHOD FOR CORRECTING THE UNEVEN DYEING PROPERTIES OF WOOL STAPLES AND OF CLOTH DAMAGED BY EXPOSURE. Race, Rowe and Speakman. *J. Soc. Dyers Col.*, April 1938, P. 159–72.

The authors' conclusions are summarized as follows: In Part I the development of different hues on exposed and unexposed parts of wool staples or cloth, when level acid dyeings are afterchromed in an acetic acid bath, has been referred to the presence of excess sulphydryl and aldehyde groups in exposed wool, which cause more complete reduction of the chromium deposited in exposed than in unexposed wool Consequently, the possibility of preventing the development of unlevelness in afterchroming, by eliminating the enhanced reducing properties of exposed wool, has been examined. Only moderate success was realized with oxidizing agents, because of difficulties associated with the oxidation of isolated sulphydryl groups attached to the main peptide chains of wool, and because of the tendency of oxidizing agents to cause further damage by attacking intact disulphide bonds. On the other hand, cyanamide forms an addition compound with sulphydryl groups, and acid dyeings of wool staples or exposed cloth, which had been treated with this reagent, were uniform in hue when afterchromed. In keeping with this result, the chromium deposited in cyanamide-treated exposed wool was found to be much less fully reduced than that deposited in untreated exposed wool. Although cyanamide treatment prevents development of different hues on exposed and unexposed wools when level acid dyeings are afterchromed, it does not diminish the necessity for using an aggregating or dispersing agent in the acid dyebath to ensure level acid dyeings. Treatment with metal salts, however, has this desirable result. For example, chromium acetate combines with sylphydryl groups in wool and is just as effective as cyanamide in preventing excessive reduction of the chromium deposited in exposed wool by chroming, and, in addition, forms linkages between the peptide chains. The existence of these linkages in chromium acetate-treated wool, and their absence from cyanamide-treated wool, have been established by showing that chromium acetate-treated fibres are more resistant to extension, have a diminished power of super-contraction and swell to a smaller extent than untreated fibres: whereas cyanamide-treated fibres are identical with untreated fibres as regards supercontraction and swelling. After chromium-acetate treatment, too, the difference between exposed and unexposed wools, as regards swelling, is considerably diminished, with the result that there is much less need for using aggregating or dispersing agents in the acid dyebath to promote level dyeing. The optimum conditions for using chromium acetate to promote level acid- and afterchrome-dyeings are to treat the material with 3% chromium acetate and 4% glacial acetic acid at 40° C. for ½ hr., the liquor-wool ratio being 50: 1. All forms of chromium acetate are not effective, and among the products so far examined the best results have been given by a basic chromium acetate that dissolves in water to give a violet solution. Before treatment, soap-scoured wool must be efficiently washed off

in order to prevent deposition of insoluble chromium compounds on the fibres. (C)

IV. Research Methods and Apparatus

Frequency Distribution of Merino Wool Fibre Thickness Measurements. A. P. Malan. *Onderstepoort J.*, 1937, V. 9, P. 259–82; abs. in *J. T. I.*, May 1938, P. A300.

The logarithmic nature of distributions in wool fibre thickness measurements has been suggested by the constancy of the coefficient of variability in previous work. The distribution of a variable, the logarithm of which is normally distributed, is discussed. The application of the "logarithmic function" to 18 different samples is given and the "fit" compared with that of the normal distribution. Two further samples, which were also measured by an anti-logarithmic scale, are included and show that the logarithms of fibre thicknesses are normally distributed. Figures are given illustrating the logarithmic nature of the distributions of fibre thickness measurements and the normality of the logarithms of such measurements. It is suggested that the logarithms of fibre thickness measurements be used for statistical analysis, the arithmetical mean being replaced by the geometrical mean to represent average fibre thickness. (C)

Illumination for Microscopes: Improved. P. P. Tarasov. *Metal Progress*, Sept. 1937, P. 266–7; abs. in *Eastman Kodak Abs. Bull.*, Feb. 1938.

The G. E. Therapeutic sun lamp has been modified by making one electrode a tungsten ring and the other a cylindrical tungsten button. The lamp burns base up so as to bring a globule of mercury near to the electrodes. The resulting light is permanent, nonfluctuating, and has a photographic efficiency about the same as that of the 110-volt carbon arc. It burns on a 110-volt a.c. supply with an autotransformer, using 300 amperes, 11 volts, and 330 watts, when heated up. The ordinary type of socket overheats, so a special ventilated type was devised. (Abstractor's Note:—The lamp is more intense than the ribbon filament, having the concentration of a Point-O-Lite but with an immovable electrode.) (S)

Measurement of Fastness to Light. E. W. Pierce. *Rayon Tex. Mo.*, April 1938, P. 81–2, 95.

The author presents the problem of fastness of color to light as it stands today, and concludes as follows: "Industry sorely needs a universal method of reporting actual fastness to light in Fadeometer or helio hours, which is not dependent on personal opinion or personal judgment. This problem is now far from solution and remains a standing challenge to the scientific world." (C)

Silk: Oxidative Degradation. Minnie Lichte and Rachel Edgar. *Iowa State Coll. J. Sci.*, 1937, V. 12, P. 1–4; abs. in *J. T. I.*, June 1938, P. A364. (C)

STAPLE FIBRE: DYE ABSORPTION AND ALKALI SOLUBILITY. Böhringer and Freund. *Klepzig's Textil-Z.*, 1938, V. 41, P. 151–4; abs. in *J. T. I.*, May 1938, P. A300.

Methods of determining the adsorptive power for substantive dyes and the alkali solubility of fibrous materials are described and results obtained for cotton and various Cuprama, Lanusa, and Schwarza staple fibre products are given and discussed. (C)

TESTING FABRICS AND DYESTUFFS BY FLUORESCENCE. C. H. S. Tupholme. *Tex. Col.*, July 1938, P. 441–3. (C)

TEXTILE ASSISTANTS: ACTION OF LIGHT ON. W. Höll. *Deut. Färber-Z.*, 1938, V. 74, P. 63–4; abs. in *J. T. I.*, April 1938, P. A234.

Marseilles soap, a fatty alcohol sulphonate, a fatty acid condensation product, Lecivon and Turkey red oil, in substance, in 10% solution, and in the form of finishes on cotton, rayon and wool, were exposed for periods of 65 hours to the Fadeometer and changes in chemical composition, lustre and white content and also changes in the softness of the textile materials were determined. The results are tabulated and discussed. The data show that the action of light produces chemical changes such as splitting or oxidation of the products, the process being frequently accompanied by polymerization or depolymerization processes. These chemical changes result in changes in lustre, white content and softness. The effect of light on the softness of wool and rayon treated with the products varies with the nature of the product used but in the case of cotton an increase in softness on exposure is observed with all the finishing agents tested. (C)

WOOL: DETECTION OF OXIDATION IN. H. A. Rutherford and Milton Harris. *B. S. J. Rsch.*, April 1938, P. 555–7; *Am. Dye. Rptr.*, April 4, 1938, P. 179–80.

A rapid and simple test for detection of oxidation in wool is described. The method utilizes the oxidizing value of some of the intermediate oxidation derivatives of the disulfide groups in wool, and is based on the ability of oxidized wool to convert a ferrous salt into ferric salt. The latter in the presence of thiocyanate gives the characteristic red color of ferric thiocyanate. (C)

WOOL FINENESS MEASUREMENT. O. Bernhardt. *Mell. Textilber.*, 1938, V. 19, P. 11–3; abs. in *J. T. I.*, June 1938, P. A363.

Reichert's lanameter for measuring fibre diameter is described and illustrated by photographs and figures. A method which is quicker in operation than the orthodox one is to use a plain and frosted screen in the lanameter instead of the graduated one, and to measure fibre diameter on this by means of a celluloid rule. The author favors the use of the metrical count. (C)

WOOL: FURTHER ADVANCES IN THE LENGTH ANALYSIS OF. Sidney Townend. *J. T. I.*, April 1938, P. T55–T66.

As shown in this paper, the length-biased sample bears, within normal sampling errors, an exact mathematical relation to the true sample, by means of which the results of the latter type of sample can be readily

converted to those of a length-biased sample. While the extraction and preparation of the sample by the author's "tong" method is slightly more involved than for the draw, gentleness of operation and not skill is the chief requirement. With the new technique, the accuracy of extracting a perfect sample is far less affected than is the draw method by the condition, state and type of wool, since the problem of uncontrolled fibres has been overcome. Preliminary disturbance of the sliver before the actual extraction of the sample, which is inevitable with the draw method of sampling, is avoided by the "tong" method. In general it is thought that personal differences in results due to slight variations in technique are likely to be considerably smaller with the "tong" than with the draw method. (C)

Wool Staple Analysis. Wm. O. Holmes. *Tex. Wld.*, May 1938, P. 62–3.

The objective of the author in the development of methods described has been to give consideration to the physical and dimensional properties of the wool fibre in the top that are of most interest to the practical mill man. He describes, also, a novel graphical method of showing the proportionate amounts of various fibres in a standard sample, and other staple characteristics, such as evenness and soundness. This type of analysis would not be found satisfactory for coarse wools, nor for scientific fibre research. (C)

V. Economic Research and Miscellany

Acid and Alkaline Degradation: Resistance of Formaldehyde-treated Wool Fabric to. R. Edgar. *Iowa Agric. Expt. Sta., Ann. Rpt.*, 1936, Part i, 157–8 (through *C. A.*, 1938, V. 32, Col. 2361); abs. in *J. T. I.*, June 1938, P. A380.

For this quantitative study of the protection formaldehyde provides wool against the degrading effect of alkali such as is used in scouring, dyeing and mercerizing and of acid such as is used in carbonizing, dyeing, lustring and mercerizing, a CH_2O-treated wool of 16.38% N, 4.61% total S, 0.78% sulphate S, no sulphite and 0.05% ash was prepared by treating plain woven undyed wool for 1 hr. at 70° in a 50-vol. bath of 1% CH_2O. This treated wool after 10 hrs. at 40° in 50-vol. baths of 0–0.4 *M* NaOH, was rinsed thoroughly and analyzed for weight, total S, sulphate S, wet breaking strength and elongation at breaking load; the CH_2O treated wool was analyzed in the same way after mercerization for 5 min. at 15° in 50 vols. of 38% NaOH, after 10 hrs. at 25° in 50 vols. of 6 *M* HCl, and after 1 hr. at 100° in 50 vols. of 0–0.75 *M* MCl. It was possible to handle the CH_2O-treated fabric at 0.4 *M* NaOH, and this wool showed a measurable wet strength at 0.2 *M*, a concentration 4 times that beyond which the untreated wool showed no measurable wet strength. The residues of the CH_2O-treated wool were nearly constant in total N and greater in weight and wet strength than those of wool. The changes upon mercerization with concentrated alkali were the same for each of the wools. In concentrated acid the CH_2O-treated wool suffered less loss of weight, N and wet strength and greater loss of S than the wool. In 1 hr. at 100° in dilute HCl the CH_2O-treated wool lost slightly less weight, approximately 5% less of its N and 12–18% more of its total S than the wool. At 0.75 *M*

HCl the CH_2O-treated wool retained 11% of its original wet strength, although the untreated wool had no measurable wet strength at 0.5 *M* HCl. (C)

ALDEHYDES ON THE QUANTITATIVE DETERMINATION OF CYSTEINE AND CYSTINE: EFFECT OF. M. X. Sullivan and W. C. Hess. *J. Biol. Chem.*, Sept. 1937, P. 537–42; abs. in *Eastman Kodak Abs. Bull.*, Feb. 1938.

Aldehydes have very little effect on the Sullivan and Okuda procedures for the determination of cystine while the inhibitory effect on the Folin-Marenzi method varies with the aldehyde used. In the determination of cysteine, the presence of aldehyde shows no effect on the Okuda method and increasing inhibitory action on the Sullivan, Folin-Marenzi, and Mason procedures. (S)

DIFFRACTION OF X-RAYS AT VERY SMALL ANGLES BY CELLULOSES AND RAYONS. G. L. Clark and E. A. Parker. *Science*, 1937, V. 85, P. 203–4; abs. in *Paper Trade J.*, May 12, 1938, P. 48.

Diagrams of the diffraction effects of native ramie, mercerized ramie dried under tension, and regenerated cellulose rayons are reproduced and discussed. (C)

ELECTROLYTIC PROPERTIES OF PROTEINS AND THEIR STRUCTURE. G. Ettisch. *J. Chim. phys.*, Aug.-Sept. 1937, P. 473–506; abs. in *Eastman Kodak Abst. Bull.*, March 1938.

The addition of acid or alkali to a protein solution, such as casein, results in an instantaneous primary reaction, which may be considered due to an ionic reaction with the "super-ampholyte" protein molecule. This reaction gives the familiar titration curve which may be expressed in regular mass action terms. The dissociation constants so obtained show a similarity to those of certain amino acids. This fact may not be said *a priori* to indicate such units in the molecule. Continued action of the alkali up to pH = 11 yields a secondary reaction which has two phases, the first of which is characterized by an increase in viscosity and the second by a subsequent drop in viscosity. This action is reversible. Above pH = 11, an irreversible time effect of alkali is observed. An explanation of the secondary reaction is attempted on the basis that change of the charge distribution on the molecule changes the bonding angles, loosens the structure, and finally results in actual dissociation. Data of neutral-salt effects and the affinities of protein for heavy metal (copper) ions are included and discussed. (S)

GELATIN, STRETCHING OF, UNDER THE INFLUENCE OF SALTS. J. H. C. Merckel and E. H. Wiebenga. *Koll.-Z.*, 1937, No. 3, P. 315–9; abs. in *Eastman Kodak Abs. Bull.*, April 1938.

The article is the second of a series on the stretching of gelatin. The stretching of gelatin gels at a pH = 3.75 under the influence of salts was determined. A bilinear expression was found to express the relation between the concentration necessary to give a fixed stretch and the lyotropic number. Salts with a lyotropic number above 9.33 increased stretching and those below 9.33 decreased stretching. A theory is advanced to explain the stretching of gelatin gels. (S)

HIGH MOLECULAR WEIGHT COMPOUNDS: THE K_m CONSTANT OF CELLULOSE ACETATE. H. Staudinger and A. E. Werner. *Ber. deut. chem. Ges.*, 1937, No. 10, P. 2140–8; abs. in *Eastman Kodak Abs. Bull.*, Feb. 1938.

It is demonstrated that the K_m constant varies in a polymerhomologous series, starting with some of the lowest members whose molecular weights can be determined cryoscopically. The K_m constant, which should be used for the higher molecular weight cellulose acetates, is obtained by extrapolation. It is found to be 5.3×10^{-4} in chloroform and 6.3×10^{-4} in m-cresol. This variation of K_m is explained on the basis that the ratio of length to width of the molecule must be large for the Staudinger viscosity equation to apply. Starch and starch derivatives show values of K_m that are one-eighth that of cellulose acetate, indicating that the chains are long but branched. (S)

HIGH-MOLECULAR WEIGHT MATERIALS: THE KINETICS OF CHAIN POLYMERIZATION. II. THE HEAT POLYMERIZATION OF STYRENE WITH EXCLUSION OF OXYGEN, AND SOME REMARKS ON THE CHAIN BREAKING. G. V. Schulz and E. Husemann. *Z. physikal Chem.*, 1937, No. 3, P. 184–94; abs. in *Eastman Kodak Abs. Bull.*, Feb. 1938.

The polymerization of styrene proceeds to the extent of 90 per cent under pure nitrogen. The degree of polymerization is more nearly constant during the course of the reaction than is the case in the presence of air. A comparison with earlier work shows that the presence of oxygen accelerates the reaction at first, but that either the chain length or the amount of branching is essentially changed. Confirmation is obtained for the earlier proposed mechanism of chain breaking as a reacting together of the growing molecules. (S)

HISTIDINE DESTRUCTION BY ASCORBIC AND THIOGLYCOLLIC ACIDS: MECHANISM OF. P. Holtz. *Z. physiol. Chem.*, 1937, No. 2/3, P. 97–103; abs. abs. in *Eastman Kodak Abs. Bull.*, 1938. (S)

HYSTERESIS OF WATER VAPOR ON CELLULOSE: INFLUENCE OF AIR. F. Walker, W. B. Campbell, and O. Maass. *Canadian J. Rsch.*, Aug. 1937, P. 340–4; abs. in *Eastman Kodak Abs. Bull.*, Feb. 1938.

A definite and constant amount of hysteresis was observed for cellulose which had been evacuated at 10^{-2} mm. and at 10^{-3} mm. of mercury. It is concluded that hysteresis is not due to absorbed permanent gases, as claimed by Hamm and Patrick (*Tex. Rsch.*, July 1936, P. 401–9). (S)

INDUSTRIAL LIGHTING: LIGHTING FOR SILK AND RAYON THROWING AND WIDE GOODS WEAVING. H. B. Dates. *Trans. Illum. Eng. Soc.*, Jan. 1938, P. 17–52; abs. in *Eastman Kodak Abs. Bull.*, Mar. 1938.

The textile industries present many unusual and difficult lighting problems. In this report, a systematic survey of the more important operations is made with an exposition of the lighting methods found most useful in each. (S)

LYOPHILIC COLLOIDS: COMPARATIVE OBSERVATIONS ON SOLUTIONS OF AMYLOSE, AMYLOPHOSPHORIC ACID, AND CELLULOSE. P. Koets and H. R. Kruyt. *Koll. Beih.*, 1937, No. 1–4, P. 100–32; abs. in *Eastman Kodak Abs. Bull.*, Feb. 1938.

Cellulose, regenerated from a diluted solution of the xanthogenate, gives stable dispersions with sodium hydroxide solutions in the concentration range between 1.5 and 3.6 N. sodium hydroxide. This upper concentration is the one corresponding to complete exchange of sodium ion for hydrogen ion of the cellulose hydroxyl groups. This complete exchange cannot be obtained with native cellulose. The lower limit of the concentration corresponds to the point at which there is on the average one sodium ion for each $C_6H_{10}O_5$ group of the molecule. (S)

MEMBRANES HAVING GRADED POROSITIES: PRINCIPLES GOVERNING THE PREPARATION OF. Properties of "Gradacol" Membranes as Ultrafilters. W. J. Elford. *Trans. Faraday Soc.*, Aug. 1937, P. 1094–1106; abs. in *Eastman Kodak Abs. Bull.*, Feb. 1938.

The mechanism of production of collodion membranes of graded porosity, *e.g.*, "Gradacol" membranes, is discussed. It is shown to be necessary to select such solvents as would ensure that the collodion under the appropriate conditions should undergo spontaneous gelatin, and also to secure a means of varying the state of aggregation of the nitrocellulose at the instant when setting occurs. The behavior of the membranes as ultrafilters is described, together with the derivation, significance, and dependability of the "Elford factor" employed in deducing the particle diameter of a suspension from the ultra-filtration data. (S)

MOISTURE CONTROL SYSTEMS: RESUMÉ OF. *Paper Trade J.*, April 7, 1938, P. 39–42.

A report on moisture control systems adapted for paper drying machines by the Sub-committee on Drying, Heating and Ventilating of the Technical Association of the Pulp and Paper Industry. (C)

MOLECULAR SIZE OF CELLULOSE FROM DIFFERENT SOURCES. I. J. K. Chowdhury and T. P. Bardhan. *J. Indian Chem. Soc.*, 1936, V. 13, P. 240–52; abs. in *Paper Trade J.*, May 12, 1938, P. 47. (C)

MOLECULAR WEIGHT AND VISCOSITY OF HIGH POLYMERS. A. Dobry. *Koll.-Z.*, 1937, No. 2, P. 190–4; abs. in *Eastman Kodak Abs. Bull.*, April 1938.

Osmotic and viscosimetric measurements were made on purified and fractionated nitrocellulose, acetyl cellulose, and polystyrene, in a number of different solvents. The osmotic measurements were carried to extreme dilutions to allow extrapolation to the limit $c \rightarrow 0$. The following conclusions were drawn: (1) the p/c—c curve is not a straight line for certain colloids (nitrocellulose, polystyrene) in certain solvents so that, in order to extrapolate to the limit $c \rightarrow 0$, measurements must be taken down to concentrations of 0.1 per cent or less. (2) The limiting values of p/c are the same for all solvents and the molecular weight so calculated is the true value independent of solvent. (3) The degree of dispersion of colloid particles in all solvents is the same at large dilutions;

thus, the colloid particle is a macromolecule, not a micelle. (4) The limiting role of n_{sp} deviates, at most, 8 per cent from an average value, showing that no abnormally large solvation of the colloid particle exists. (5) Staudinger's viscosimetric determination of molecular weight is not admissible; different fractions have different viscosities but the same molecular weights. (6) The method of osmotic pressure is the single unexceptional method of determining the molecular weights of high polymers. (S)

MOLECULAR WEIGHT AND THE VISCOSITY OF HIGH POLYMERS. (Comments on the work of A. Dobry, *Koll. Z.*, 1937, No. 2, P. 190–4.) H. Staudinger. *Ibid.*, 1938, No. 2, P. 129–31; abs. in *Eastman Kodak Abs. Bull.*, April 1938.

The author maintains that Dobry's work verified several facts concerning these high polymers which had been pointed out previously by him, *i.e.*, the existence of a macromolecular as contrasted with a micellar structure of the particle and the absence of large solvation. He states that the reason Dobry found different viscosities for two polystyrenes of the same molecular weight is that they are not polymerhomologous. Polystyrenes prepared at different temperatures possess different degrees of branching. If two samples of different molecular weights are prepared at the same temperature, they will show the same K_m. He claims viscosity data are of value in determining the shape of the molecule when used in conjunction with osmotic data. He cites his own work showing that glycogen is a spherical molecule, starch, a highly branched straight chain, and cellulose, a linear colloid. (S)

OXIDATION OF CELLULOSE. L. Brissaud. *Mém. Poudres,* 1937, V. 27, P. 195–213; abs. in *Paper Trade J.*, May 12, 1938, P. 48. (C)

PHENOL AND CRESOL RESINS: RESEARCHES ON. R. Seebach. *Kunststoffe,* Nov. 1937, P. 287–90; abs. in *Eastman Kodak Abs. Bull.*, March 1938.

The formation of phenol resins is explained by means of the crystalline intermediates. They can also be identified in the manufactured resins, in which they are present in solid solution. They can be obtained from cresol resins as well as from phenol resins. In every case, they are an essential constituent of the resin itself. Nine photomicrographs of intermediates are included. (S)

PROTEINS: HOW TO DETERMINE STRUCTURAL FORMULAE FOR. W. D. Bancroft and H. F. Browning. *J. Phys. Chem.*, Dec. 1937, P. 1163–70; abs. in *Eastman Kodak Abs. Bull.*, March 1938.

Some preliminary data and observations of the progress of the hydrolysis of casein with hot dilute (4%) sulfuric acid are recorded and discussed. The dilute acid is preferred because of the possibility of examining intermediate stages in the hydrolysis. Rather than attempt the isolation of the fragments, observations are made of the changes in stoichiometric nitrogen (that which combines in the solid with dry hydrogen chloride gas) and ammonia nitrogen. (S)

TEXTILE LIGHTING WITH PARTICULAR REFERENCE TO COLOR DISCRIMINATION. J. W. Howell. *J. Soc. Dyers Col.*, July 1938, P. 293–301. (C)

WATER REMOVAL FROM PULP AND PAPER. T. K. Sherwood, H. S. Gardner and R. P. Whitney. *Paper Trade J.*, June 16, 1938, P. 29–35.

Data are presented on the water removal from pulp and paper, as obtained from the fourdrinier and press section of a sulphite pulp machine and from a drum drier operating on sulfite bond paper. The results obtained from the pulp fourdrinier indicate the distribution of water removal from the various parts of the machine. The effect of temperature on the water removal is discussed. The study of drying as it actually occurs on the paper machine yielded results which compare very closely with laboratory data on the air drying of sulfite pulp sheets. Periods of constant rate and falling rate drying were clearly indicated. Sheet temperature measurements were obtained from which it was calculated that about 80% of the water removal occurs while the sheet is in actual contact with the rolls. It follows that the greater part of the water is transferred from the sheet to the felt, rather than directly to the air, and the importance of the felt in machine drying is discussed. (C)

TEXTILE RESEARCH: PROSPECTS BRIGHTEN FOR BROADER—AS ONLY ROAD TO BETTER GOODS AND LOWER COSTS. H. L. Mereness. *Text. Age.*, July 1938, P. 40–4. (C)

X-RAY MICRO-ANALYZER. L. von Hamos. *Nature*, July 3, 1937, P. 30; *J. Sci. Instruments*, Mar. 1938, P. 87–94; abs. in *Eastman Kodak Abs. Bull.* July 1938.

The method of obtaining images from the secondary x-ray spectrum is described in some detail, together with the mathematical formula required for setting up the system and for focusing the image. A cylindrical reflector of rocksalt is used. In mineralogy and metallography, it can be used to show the analysis of the surface layers of the ore or mineral under examination. (S)

Book Reviews

AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS 1938 YEAR BOOK. Howes Publishing Co., New York, N. Y. Price $3.00.

While this volume of 660 pages, inclusive of advertising, list of members and index, has not been completely revised, it contains extensive revisions of the parts related to organization, committee reports and standard test methods. The year book and the association's official magazine are free to members. (C)

A. S. T. M. STANDARDS ON TEXTILE MATERIALS. American Society for Testing Materials, Philadelphia, Pa. Pp. 330, price $2.00.

This 1938 edition, compiled by Committee D–13 on Textile Materials, contains the latest available revisions of specifications, tolerances and testing methods, together with abstracts of papers presented at the October, 1937, and March, 1938, meetings. (C)

COTTON. Harry Bates Brown. McGraw-Hill Book Co., New York, N. Y. Price, $5.00.

The author is in charge of cotton breeding at Louisiana State University. The book is designed as a text book for agricultural students, and in addition to its coverage of cotton growing, breeding and marketing provides a summary of manufacturing processes. (C)

COTTON CLASSING MANUAL. H. H. Willis. Gaston Gate and B. V. Moore. Multilithed. Price, $1.25.

While basicly a teaching manual, prepared for the use of textile students, it is also of value as a reference work. It is one of a series of seven books on cotton yarn manufacture prepared under the direction of H. H. Willis, dean of Clemson College (S. C.) Textile School, and sponsored by The Textile Foundation. (C)

HANDBOOK OF INDUSTRIAL FABRICS. Second edition. George B. Haven. Wellington, Sears & Co., New York, N. Y. Price, $2.00.

Revisions and additions bring this reference book up-to-date. It is a condensation of the author's extensive volume "Mechanical Fabrics." (C)

MERCHANDISE TESTING AS A GUIDE TO CONSUMER BUYING. Mabel T. Gragg and Neil H. Borden, Bureau of Business Research, Harvard School of Business Administration, Boston, Mass. Pp. 84, price, $1.00.

The reason for and the purpose of this study are stated in the Foreword as follows: "Various proposals which have been advanced for providing consumers with a rational basis for buying accept the merchandise test as the appropriate and adequate tool by which to assemble objective evidence as to merchandise valued. . . . It is the purpose of this study to inquire into the problems inherent in merchandise evaluation and to mark off, at least roughly, those limits within which goods can be appraised for consumers to their advantage and beyond which appraisals become of small help."

The concluding paragraph of this fair and sound analysis of the inherent problems provides a reliable guide for consumer buying, and for winning consumer good will: "In the last analysis it is upon the integrity of producers and distributors that buyers must rely. No quantity of laws and no amount of supervision can suffice for the production of sound goods, or for the selection of sound goods by distributors, if the producers have no interest in making their goods sound and if the distributors have no interest in offering sound merchandise. No amount of specifications, testing and grading can definitely assure the soundness of merchandise unless there is a presumption of integrity behind it." (C)